Name _____

Evidence of Chemical Change

Your Tasks (Mark these off as you go)

- ☐ Define key vocabulary
- ☐ Classify a reaction given a laboratory description
- ☐ Balance reactions
- ☐ Observe evidence of chemical reactions
- ☐ Write reactions to describe laboratory situations
- ☐ Receive credit for this lab

❑ Define key vocabulary

Single replacement reaction

Double replacement reaction

Synthesis reaction

Decomposition reaction

Combustion reaction

Precipitate

❑ Classify a reaction given a laboratory description

We learned previously that there are several different ways of classifying chemical reactions. The classification schemes described here provides useful guidelines for predicting reaction types. The types of reactions described are synthesis, decomposition, single-replacement, double-replacement, and combustion.

Reaction Type	**Description**	**Examples**
Synthesis	two or more substances combine to form a new compound	$Mg(s) + O_2(g) \rightarrow MgO(s)$ $NaO(s) + H_2O(l) \rightarrow NaOH(aq)$
Decomposition	A single compound separates to produce two or more simpler substances.	$HgO(s) \rightarrow Hg(l) + O_2(g)$ $KClO_3(s) \rightarrow KCl(s) + O_2(g)$
Single replacement	One element replaces a similar element in a compound	$Na(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$ $Cl_2(g) + KBr(aq) \rightarrow KCl(aq) + Br_2(l)$
Double replacement	The ions of two compounds exchange places to form two new compounds	$Pb(NO_3)_2(aq) + KI(aq) \rightarrow PbI_2(s) + KNO_3(aq)$ $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
Combustion	A substance made up of carbon and hydrogen reacts with oxygen to produce carbon dioxide and water.	$C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$ $C_{12}H_{22}O_{11}(s) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

For each of the laboratory situations described below, (a) Write the corresponding reaction (b) Classify the reaction as one of the 5 types described above
1. When powdered barium hydroxide ($Ba(OH)_2$) is mixed with a solution of silver nitrate ($AgNO_3$), aqueous barium nitrate ($Ba(NO_3)_2$) is produced and silver hydroxide (AgOH) precipitates
(a)
(b)
2. When zinc (Zn) metal is placed in a solution of silver nitrate ($AgNO_3$), aqueous zinc nitrate ($Zn(NO_3)_2$ is produced and silver (Ag) precipitates.
(a)
(b)
3. When liquid methanol (CH_3OH) is burned, carbon dioxide (CO_2) gas and water (H_2O) vapor are produced.
(a)
(b)
4. When powdered potassium chlorate ($KClO_3$) is heated, solid potassium chloride (KCl) and oxygen gas (O_2) are produced.
(a)
(b)
5. When powdered iron(II) sulfide (FeS) is mixed with a solution of hydrochloric acid (HCl), hydrogen sulfide gas (H_2S) and aqueous iron(II) chloride are produced.
(a)
(b)

6. When sodium oxide (Na_2O) is placed in water (H_2O), aqueous sodium hydroxide (NaOH) is produced
(a)
(b)

❑ Balance reactions

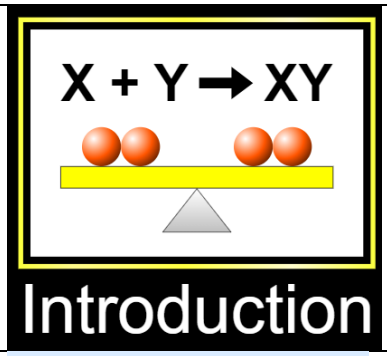
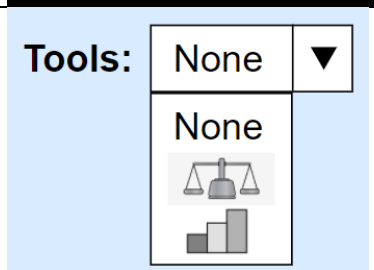
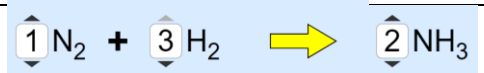
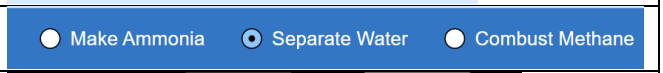
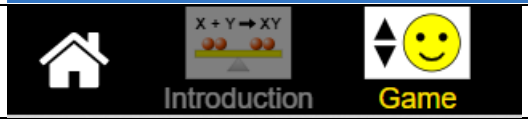
Conservation of mass states the mass is neither created nor destroyed, therefore everything that appears on the left of a reaction must appear on the right. Consider the balanced reaction shown below,

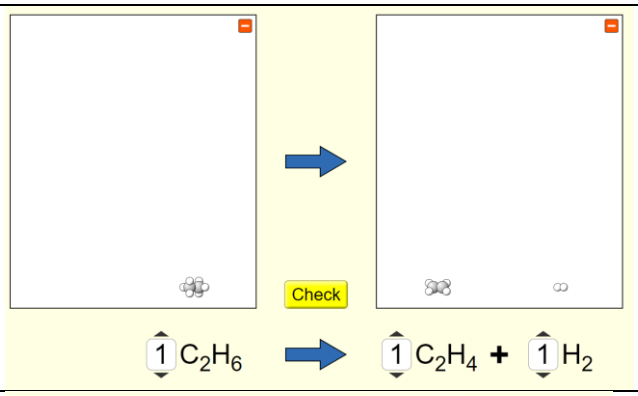
Substance	$2Al + 3ZnCl_2$	→	$3Zn + 2AlCl_3$
Al	2		2
Zn	3		3
Cl	6		6

Notice above that there are equal numbers of each element on each side of the arrow. The reaction is therefore said to be "balanced".

There is no one-way to balance a chemical equation, but the following guidelines are useful,

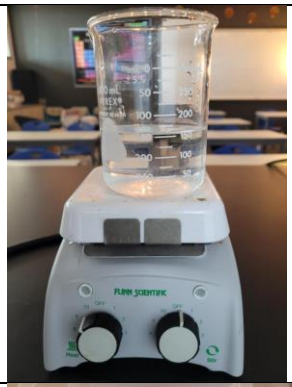
- Balance the atoms that appear only once on each side of the equation first
- Balance polyatomic ions that appear on both sides of the equation as single units
- Balance H atoms and O atoms last
- If water appears in the reaction, write it as HOH. Balance H and OH separately.

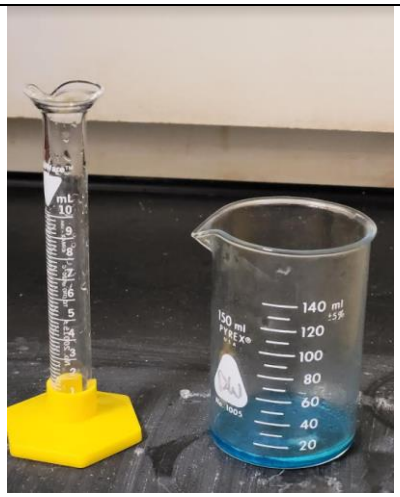
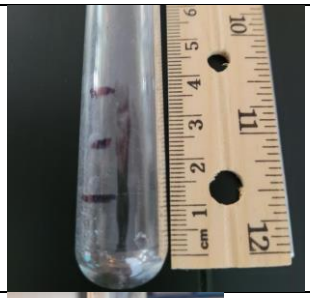
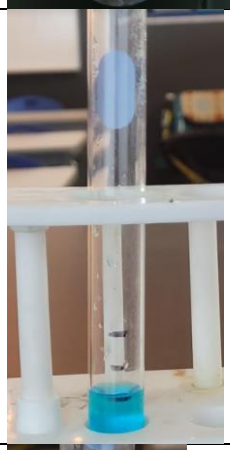
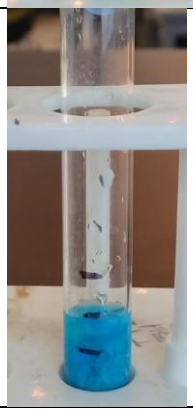
Navigate to the balancing equation simulator https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_en.html And, select the *Introduction* option	
From the tools drop down, select the scale	
Use the arrows to change the coefficients and balance the equation	
Complete equation by selecting the options	
Select the *Game* option at the bottom of the simulation window	

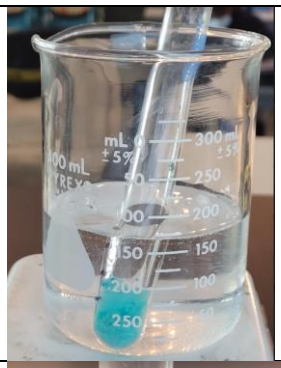
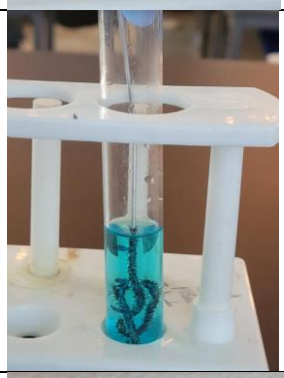
Balance the equations as you did before. When you are done, select the *Check* button	
Take screen shot of your final score and paste it in the box below	

Paste a screen shot of your results in the below.

❑ Observe evidence of chemical reactions

Procedure	
Step 1. Place about 150 mL of water into a 400 mL beaker, then heat until boiling	
Step 2. While the beaker of water heats up, measure out between 0.60 and 0.65 g of copper. Transfer the copper in a 150 mL beaker. Describe the appearance of your copper in the data table below.	

Step 3. This step MUST be done in the fume hood. Deadly gases are released during this step! Nitric acid is extremely corrosive and will cause severe chemical burns. Very carefully measure out 3 mL of nitric acid in a 10 mL graduated cylinder. Then pour the nitric acid into the beaker containing the copper. Allow the copper to completely react. Once the copper has completely reacted, measure out 7 mL of water in a graduated cylinder and add this to the beaker. Record your observations and evidence of chemical change in the data table below.	
Step 4. Obtain a test tube and using a ruler make three marks on it about 1 cm apart.	
Step 5. Pour the solution in your beaker into the test tube up to the first mark. Discard any remaining solution in the waste bucket.	
Step 6. Add 1.0 M Sodium hydroxide up to the second mark on the test tube. Slightly mix the solutions by tapping the tube gently on the palm of your hand. Record your observations and evidence of chemical change in the data table below.	

Step 7. Put the test tube into the water bath you prepared in step 1. Heat it until no more changes occur. Record your observations and evidence of chemical change in the data table below.	
Step 8. Remove the test tube from the hot water bath. Turn off the hot plate. Cool the test tube for 2 minutes in a beaker with room temperature water. Then add 3.0 M HCl to the 3rd , mark. Record your observations and evidence of chemical change in the data table below.	
Step 9. Place a 12 cm piece of aluminum wire in the test tube. Leave it until no reaction is observed. Record your observations and evidence of chemical change in the data table below.	
Step 10. Remove the wire from the test tube and place it on a paper towel. Compare the copper formed to the original sample. Record how the copper you recovered at the end compares to the original sample in the data table below.	
• Rinse the aluminum wire and return it to the used aluminum wire container • Discard all additional waste in the designated waste bucket • Rinse your supplies in the sink and return them to the supply cart	

Data Table 1. Observations of chemical change

Step 2	
Step 3	
Step 6	
Step 7	

Step 8	
Step 9	
Step 10	

❑ Write reactions to describe laboratory conditions

The reactions that took place in steps 3, 6, 7, 8, and 9 are described below. For each reaction, (1) Write a chemical reaction using the appropriate symbols. (2) Balance the reaction (3) Identify the type of reaction

Step 3	
When concentrated nitric acid (HNO_3) is added to copper (Cu), aqueous copper(II) nitrate ($Cu(NO_3)_2$), nitrogen dioxide (NO_2) gas, and water (H_2O) is produced.	
Balanced reaction	
Type of reaction	
Step 6	
When aqueous copper (II) nitrate (HNO_3) and aqueous sodium hydroxide (NaOH) are mixed, copper (II) hydroxide ($Cu(OH)_2$) precipitates and aqueous sodium nitrate ($NaNO_3$) is produced.	
Balanced reaction	
Type of reaction	
Step 7	
Solid copper (II) hydroxide ($Cu(OH)_2$) , when heated, produces solid copper (II) oxide (CuO) and water (H_2O)	
Balanced reaction	
Type of reaction	
Step 8	
Aqueous hydrochloric acid (HCl) reacts with solid copper (II) oxide (CuO) to produce aqueous copper(II) chloride ($CuCl_2$) and water (H_2O)	
Balanced reaction	
Type of reaction	
Step 9 (There are two reactions here)	
Aqueous copper (II) chloride ($CuCl_2$) and aluminum (Al) metal react to produce copper (Cu) metal and aqueous aluminum chloride ($AlCl_3$)	
Balanced reaction	
Type of reaction	
Aluminum (Al) metal reacts with aqueous hydrochloric acid (HCl) to produce hydrogen (H_2) gas and aqueous aluminum chloride ($AlCl_3$)	
Balanced reaction	
Type of reaction	

❑ Receive Credit for this lab

Submit your completed lab to receive credit.